J Young Pharm, 2019;11(3):254-260
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Original Article

Identification and Validation of Different Types of Fruit of Haritaki (*Terminalia chebula* Retz.) in North-Western Ghats of North Karnataka with Special Reference to HPTLC

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ABSTRACT

Background: The fruit of Myrobalan (*Terminalia chebula* Retz.) is considered as Amruta (Nectar) and 'King of Medicines' in Ayurveda, it known to be have 7-varieties with differences in botanical and pharmacological characters. Actual identification of these variety and it's botanical correlation was not done. Thus, present study was done to identify these varieties in North-Western Ghats of North Karnataka and correlate its chemo-profile by HPTLC method. **Methods:** A prospective survey study was conducted in 10 localities of north-western Ghats of north Karnataka along with GPS system and identified and collected. The fruit was analyzed on Shape, Size, Dimension, Weight per fruit, color, mesocarp contents, seed character and size in relation with Ayurvedic classification and respective microscopic histology and Powder characters, Physico and phyto-chemical, HPTLC. **Results:** The study identified 5 varieties as Vijaya (*Termenalia chebula* Ver. 2 (typica)), Rohini (*Termenalia chebula* Ver. 3 (citrina)), Pootana (*Termenalia chebula* Ver. Tomentella), Amirtha (*Termenalia chebula* Ver. Gangitica) and Abhaya (Termenalia chebula Ver. Parviflora, Thewaites Enum). Further, each variety has difference on its botanical, organoleptic, physicochemical analysis. The % of Chebulinic acid was maximum of 6.4% in abhaya compare to least in Amritha of 3.8% and Gallic acid is more in Rohini (4.3%) compare to least in Pootani (2.1%) and rest of other chemicals were identified in traces. **Conclusion:** The study potentially demonstrated the availability of varieties of Myrobalan, there was enormous differences on its phyto-chemicals by HPTLC.

Key words: Haritaki, Myrobalan, HPTLC, Chebulinic acid, Gallic acid, Ayurveda.

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DOI: 10.5530/jyp.2019.11.52

INTRODUCTION

Myrobalan (*Haritaki*) or *Terminalia chebula* Retz. is a member of the Combretaceae family, is used widely in Asian countries as a traditional folk medicine or Ayurveda. Moreover, this plant is considered as *Amruta* (Nectar) and 'King of Medicines' in Ayurveda because of it's wide range of therapeutic benefits from mild purgative to immune modulation.[1] Because of its huge beneficial effects this plant has gain special attention in Ayurveda by providing details about its botanical and pharmacological characters.

In Ayurveda, The *Bhavaprakash* lexicon has described *T. chebula* varieties along with sources, identity features and therapeutic uses as presented in Table 1.[2] Likewise, Hooker's flora of British India has identified this plant in to 6-different varieties as[3] *Terminalia chebula* Retz. (Variety chebula proper), *Terminalia chebula* (var. typica), *Terminalia chebula* (Var. citrina), *Terminalia chebula* (Var. tomentella Kurz.), *Terminalia chebula* (Var. gangetica Roxb) and *Terminalia chebula* (Var. parviflora Thwaitos Enum.). Similarly these various varieties may clubbed identified as 2 varieties by Brandis as Ordinary variety and Tomentose form.[4] In spite of vast therapeutic use of *T. chebula*, the identification and correlation with botanical sources and variation in chemo-profile is yet to be known.

Terminalia chebula Retz. is a medium sized deciduous tree grows up to 25 m tall with broadly elliptic leaves clustered at the ends of branches. The leaves are alternate or opposite, thin-coriaceous, ovate or elliptic-obovate. Flowers in axillary long spikes, simple or sometime branched, about 4 mm across, yellowish-white and unpleasantly scented. The fruits of this plant are spherical to ovoid, 1.2 to 3.5 cm in diameter and tapering towards both the ends. The dry fruits are grayish brown in colour, pubescent and slightly ridged.[5-7] These fruits of *T. chebula* are rich in tannins (about 32%-34%),[8,9] of which gallic acid, chebulagic acid, ellagic acid, chebulinic acid are hydrolysable tannins, phenolics and anthraquinones.[10] polyphenols are present in traces.[11-13] Fatty acids include palmitic acid, linoleic acid and oleic acid.[14] Triterpenoid glycosides such as chebulosides I and II, arjunin, arjunglucoside, 2α-hydroxyursolic acid and 2α-hydroxymicromiric acid also have been reported.[15]

This plant is found in the Sub Himalayan tracks from Ravi eastwards to West Bengal and Assam, ascending upto the altitude of 1500 m in the Himalayas. This tree is wild in forests of Northern India, central provinces and Bengal, common in Madras, Mysore and in the southern part of the rainy and moderate temperate region of Bombay presidency.[16]Western ghat is one of the biological hot spot situated in India it has wide range of plant and animal Kingdome. One such popular plant Kingdome available is *T. chebula.* The primary report published by Regional Medical Research Centre (RMRC a unit of ICMR) suggested that different shapes of fruits of *T. chebula* are available in Western Ghats of North Karnataka thus present area was selected. Phytochemical evaluation is one of the tool for the quality assessment, which includes preliminary phytochemical screening, chemoprofiling and marker compound analysis using modern analytical techniques. In the last two decades High Performance Thin Layer Chromatography (HPTLC) method has emerged as an im-

portant tool for the qualitative and quantitative phytochemical analysis of herbal drugs and formulations. Fruits of *T. chebula* have different therapeutic actions with respect to different types. Hence, present study was thus planned with the objective of identify the different available types of fruit of *Haritaki* (*Terminalia chebula* Retz.) in North-Western Ghats of North Karnataka and to evaluate the chemo-profile variation of identified varieties of fruit of *Haritaki* (*Terminalia chebula* Retz.) by HPTLC.

MATERIALS AND METHODS

A prospective survey study was conducted across north-western Ghats of north Karnataka to identify and collect the fruits and *Terminalia chebula* Retz. Rutin, quercetin, chebulinic acid and gallic acid were procured from Natural remedies, Bangaluru. Toluene, acetone, ethyl acetate, dichloromethane, formic acid, glacial acetic acid and methanol etc. are analytical grade purchased from E-Merck and silica gel F254 precoated TLC aluminium plates (E-Merck) were used.

Survey Localities and Effort

During the study period investigator has visited 10 localities across north-western Ghats of North Karnataka (From 14°C 46' N - 75°C 12' E to 15°C 52' N - 74°C 34' E): which includes 7 reserved forests as Jamboti and Kanakumbi, Dandeli, Ganesh Gudi, Gungargatti, Kappatgudda and Tadasa and 3 plantations landscape are Karnataka University Herbal Garden Dharwad, Bhimgad Wildlife Sanctuary Jamboti, Belgaum and Bakala herbal Garden Sirsi. Karawar of North Karnataka with GPS system. Each area was primarily visited to locate plant of *Terminalia chebula* Retz. and noted in GPS system. Thus, identified plants of area were further visited three times (Summer, Rainy and winter) to note plant morphological and botanical identification in details.

Plant Identification

A team including Principal Investigator (PI), Co-investigator (Co-PI) and Field collector were locate tree of TC on their first field visit then plant identification was by preparing voucher specimen along with herbarium in coordination with Scientist of Regional Medical Research Centre (RMRC) a unit of ICMR Belgaum and preserved at Dept of Dravyaguna RGES AMC Ron. In successive three field visit, identified plants were studied on its morphology and fruit etc.

Fruit collection

Thus, identified plants from 10 localities fruits were collected after full maturity and analyze according specified assessment criteria. All the collected varieties are carefully photographed and preserved.

Assessment of fruit

Shape, Size, Dimension, Weight per fruit, color, mesocarp contents, seed character and seed size etc. were assessed and compared with Table 1 of Ayurvedic classification of fruit.

Further each classified fruit was further analyzed on its microscopic histology and Powder characters, Physico-chemical and Phytochemical study. All these examinations were done at Research Analytical Lab (Government of Karnataka Supported Laboratory) of Rajiv Gandhi education Society's Ayurvedic Medical College, Hospital and PG Research Centre, Ron. India.

HPTLC Study

Study was done at GMP certified Anchrome Laboratory Mumbai.[17] Dried fruits were made into coarse powder and extracted with ethyl alcohol and water by soxhlet apparatus. The extract was filtered using Whatman filter paper and then concentrated in vacuum and dried.

Preparation of Standard and Sample Solutions

Gallic acid, rutin, chebulin acid and quercetin 10 mg were accurately weighed into a 10 mL volumetric flask, dissolved in 5mL methanol and the solution was made up to 10 mL with the same solvent (1 mg/mL). 5 varieties of *T. chebula* fruit extract was accurately weighed (100 mg) into a 10 mL volumetric flask, dissolved in methanol and then solution was filtered through Whatman filter paper No. 42 and the filtrate was made up to the mark with methanol.

Development of HPTLC Technique

Alcoholic and water extracts of 5-varieties of *T. chebula* and standard methanolic Rutin, Querceitn, Chebulinic acid and gallic acid were spotted on a specified TLC sheets (20x10cm, 0.2mm thickness) as 8mm wide band width by using automatic TLC applicator CAMAG TLC Sampler 4 (ATS 4),10mm from the bottom. The Mobile phase used was Ethyl formate: Toluene: Formic acid: Water (30:1.5:4:3 v/v/v/v). The plates were kept for saturation in twin trough chamber for 20min. After development the plates were dried in air and scanned at 190 - 450 nm for Rutin, Querceitn, Chebulinic acid and gallic acid by using CAMAG Scanner 4 operated by wincats software 4.03 version. The plates were photographed after derivatization with Natural products at white light and 366 nm by using CAMAG TLC Visualizer 2.

RESULTS

The study has reported 5 varieties *Terminalia chebula* and preserved. The collected samples of voucher specimen and herbarium were prepared and discussed with Scientist of RMRC Belgaum and preserved at Dept. of Dravyaguna RGES Ayurvedic Medical College and Hospital Ron with specimen no RGES/CRC/AUT/20A/16. These plants are identified as *Termenalia chebula* Ver. 2 (typica), *Termenalia chebula* Ver. 3 (citrina), *Termenalia chebula* Ver. Tomentella, *Termenalia chebula* Ver. Gangitica and *Termenalia chebula* Ver. *Parviflora,* Thewaites Enum. Further, each

Table 1: Ayurvedic Varieties of *Terminalia chebula* Retz. with properties.[7]

Sl. No	Variety	Textual Characters	Presumed Characters	Uses
1.	Vijaya	Having Alabu (Fruit of Lagenaria vulgaris Ser.) shape	Elongated shape without ridges and <8gm	Used in all diseases
2.	Rohini	Round in shape	Circular, without ridges yellow color	Used in vrana (ulcer)
3.	Pootana	Size is small, with stony mesocarp and big seed	Very small size with <4gm weight with stony mesocarp and big seed	External purpose
4.	Amirtha	Mesocarp is more and fleshy	Mesocarp is more and fleshy with small seed <7gm	Used for shodhana karma (Purification)
5.	Abhya	Fruit having five ridges	Fruit having five ridges and weighs 7-9gm	Used for eye diseases
6.	Jivanti	Fruit is golden yellow	Fruit is golden yellow	Used for all diseases
7.	Chetaki	Fruit having three ridges	Fruit having three ridges and weighs 5-7gm	Used as purgative

variety of TC was analyzed based on external features and organoleptic qualities are presented in Table 2 and Figure 1 to 5. Plant wise analysis showed that the *Amrita* variety has bigger leaf with 7-9cm length and 5-8 cm breadth compare to *Rohini* of 3-6cm in length and 3-5 cm breadth with variations in color and shape and hairy nature. Flower color is varies from white and yellow in *Abhaya*, *Pootana* and *Vijaya*, *Rohini* and *Amrita* respectively. The biggest among the fruit is Amrita with 3.5-4.8X3.5-4CM dimension compare to *Pootani* 2-3X1.5-2.5cm, the shape is varies from spherical to spindle and ridges were prominent in *Abhaya*, *Vijaya*, *Rohini* and *Amrita* as presented in Table 3. Physicochemical study of different fruits suggests there is no much difference was seen among the varieties (Table 4).

The microscopic study of fruits showed that the pericarp having epidermis with single layered made of cells having a swollen base and hair like prolongation with dimension of 168 µm -91 µm length and breadth of 14-7 µm. The cortex is wide made up of parenchyma cells without intercellular spaces some of which contain rosette like crystals of calcium oxalate. It is intermingled with stone cells of diverse shapes. The stone cells found towards the periphery are tangentially elongated with narrow lumen. The diameter of the stone cells become lesser and the size of the lumen increases towards the inside. The central region is occupied by round or oval stone cells found in groups, having broad lumen. Most of the cells of the cortex contain simple or compound starch grains; the vascular bundles are conjoint, collateral and endarch. The powder examination indicates it is smooth, light yellow to brownish, astringent with characteristic odour. The fluorescence study has shown the different color in different variety of fruit as presented in Table 5. Preliminary phytochemical analysis of the aqueous and alcoholic extract revealed the presence of glycosides, flavonoids, tannins, phenols, saponins, diterpenes, carbohydrates and proteins etc. (Table 6).

The HPTLC study suggested that the alcoholic and water extract of different varieties showed the presence of Chebulinic acid and Gallic acid at the Rf value of 0.332 +/-0.010 and 0.782 +/-0.010 respectively Figure no. 6 -7. Rutin and Quercetine were not reported in our study since these are more soluble in Methanol rather in Alcohol.[18,19] The percentage of Chebulinic acid was more in *Abhaya* water extract (3.82%) than *Vijaya*

Table 2: Relative morphological study of *Terminalia chebula* Retz.

Sl. No	Variety	Ayurvedic textual Characters		Flora of British India	Observation
1.	Vijaya *Termenalia chebula* Ver. 2	Having *Alabu* (Fruit of *Lagenaria vulgaris* Ser.) shape	Elongated shape without ridges and <8gm	Leaves nearly glabrous beneath or the interstices of the ultimate nerves with minute sunk white tomentum with young ovary quite glabrous with ovate fruit and round based leaves	Flask or Bottle shape with dark yellow colour with less prominent ridges. **Size**: 3.5 to 5CM L, 1.5 to 2.5cm Breadth with 4.8 to 5.6gm weight per fruit. Mesocarp is light yellow color with 0.4 to 0.8cm thickness. Seed is stony hard with oval shape and Cream color with size of 1.7 to 2.3cm Length and 1 to 1.2cm Breadth. Centre of seed, Brown color two cotyledon with radical and plemule seen. The endosperm is varies from 0.3 to 0.4cm circumference
2.	Rohini *Termenalia chebula* Ver. 3	Round in shape	Circular, without ridges yellow color	Adult leaves very shaggy beneath, fruit much smaller often ¾ inch with small tree	Spherical to Ovular shape and dark yellow colored with slender hairs on its surface. Size is of 2.5 to 2.4cm L, 1.5 to 2cm Breadth and 3.01 to 3.31gm weight per fruit. Mesocarp is dark yellow with 0.2 to 0.3cm thickness **Seed**: Big stony hard, cream colored Oval to spherical shape with 1.5 to 1.9cm Length and 1.3 to 1.5cm Breadth. Endosperm is white color varies from 1 to 1.2cm L and 0.4 to 0.5cm breadth which is covered by brown inter cotyledon membrane.
3.	Pootana *Termenalia chebula* Ver. *Tomentella*	Size is small, with stony mesocarp and big seed	Very small size with <4gm weight with stony mesocarp and big seed	Leaves when young densely coppery-pubescent beneath, when adult pubescent or glabrous. Fruits ovoid hardly 1inch	Spherical to Ovular shape and dark yellow colored with with slender hairs on its surface. **Size**: 2 to 3CM L and 1.5 to 2.5cm Breadth with 4.5 to 5.3gm weight per fruit. mesocarp is light yellow hard with 0.3 to 0.4cm thickness Seed is big Stony hard with spherical shape and cream color with size of 1.5 to 2.2cm Length and 1.3 to 1.5cm Breadth. Endosperm is white with 0.5 to 0.7cm L and 0.3 to 0.5cm breadth.
4.	Amirtha *Termenalia chebula* Ver. Gangitica	Mesocarp is more and fleshy	Mesocarp is more and fleshy with small seed <7gm	Adult leaves with brown red silky hairs on the both surfaces (some time extends to stems also)	Ovular to quadrangular in shape with dark yellow to brown in colour. The hairs are prominent with reddish colored during in young stage and have a 3-4 prominent ridges. **Size**: 3.5 to 4.8CM L and 3.5 to 4cm Breadth with 7.3 to 8.5gm weight per fruit. The mesocarp is brown color with 0.5 to 1.2cm thickness. The seed is stony hard with Oval to spherical shape and light reddish color with size of 1.9 to 2.5cm Length and 1.5 to 2.5cm Breadth. Endosperm is white with 1.3 to 2cm L and 0.5 to 0.7cm breadth.
5.	Abhya *Termenalia chebula* Ver. *Parviflora, Thewaites Enum.*	Fruit having five ridges	Fruit having five ridges and weighs 7-9gm	Calyx teeth pubescent, flowers and fruits are not smaller. Fruits more acutely ribbed	Spindle shape with wide in the middle then tapering ends and Dark yellow colour with Glabrous/Shiny surface with 5-Prominent ridges. Size is of 3 to 4 CM L and 2 to 2.5cm Breadth with 5 to 7.8gm weight per fruit. The mesocarp is slight pinkish to light yellow color with 0.3 to 0.5cm thickness with 5 hallow scattered across diagonal mesocarp. Seed is big Stony hard with Oval shape and Cream color with size of 1.5 to 2.5cm Length and 1 to 1.5cm Breadth. The endosperm is of white color with 0.5 to 0.7cm L and 0.4 to 0.5cm breadth.

Table 3: ***Terminalia chebula*** **Retz. Plant morphology.**

Sl. No	Character	Vijaya	Rohini	Pootana	Amirtha	Abhaya
Leaves						
1	Size	5–7cm L and 4–6 cm B	3–6cm L and 3–5 cm B	5–7cm L and 4–6 cm B	7–9cm L and 5–8 cm B	5–7cm L and 3–5 cm B
2	color	Green	Green	Young: Reddish Adult: Green	Greenish	Yellowish green
3	Shape	Elliptic with round base	Ovate with round base	Lanceolate to ovate-lanceolate	Ovate-lanceolate	Lanceolate with round base
4	Hairy Nature	Slightly glabrous	Slight hairs on both surfaces	Adult: Pubescent	Brown silky hairs on both surfaces	Glabrous or shiny
Flowers						
5	Color	Yellowish	Yellowish	Whitish	Yellowish with pink stalk	Whitish
6	Inflorescence	Terminal spike with panicles	Terminal spike with panicles	Terminal spike with panicles	Terminal spike with panicles	Terminal spike with panicles
7	Size of flower	0.5 to 0.7CM	0.4 to 0.6CM	0.5 to 0.7CM	0.5 to 0.6CM	0.5 to 0.6CM
8	Ovary nature	Ovary glabrous	Ovary glabrous	Pubescent ovary	Ovary glabrous	Pubescent calyx and ovary
Fruits						
1	Size	3.5-5X1.5-2.5	2.5-2.4X1.5-2	2-3X1.5-2.5	3.5-4.8X3.5-4	3-4X2-2.5
2	Shape	Bottle or flask	Round	Spherical to ovular	Ovular to quadrangular	Spindle shape
3	Color	Dark Yellow	Dark Yellow	Dark Yellow	Dark Yellow to brown	Light Yellow
4	Weight per fruit	4.8-5.6GM	3-3.3GM	4.5-5.3GM	7.3-8.5GM	5-7.8GM
5	Hairy nature	Nil	Slight hairs	Slight hairs	Reddish hairs when it is young	Glabrous/Shiny
6	Ridge	Ridges not prominent	No ridges	No ridges	3-4 prominent ridges	5- Prominent ridges

Table 4: **Physicochemical study.**

Variety	Vijaya	Rohini	Pootana	Amirtha	Abhaya
Ash value	3.2%	3.4%	3.7%	4.1%	4.2%
Acid in insoluble ash	0.3%	0.3%	0.4%	0.4%	0.5%
Water soluble ash	6%	5%	5%	6%	7%
extractive value water	43%	54.5%	57%	56%	54.5%
Alcoholic extractive value	46%	49%	48%	35%	42.5%
Moisture content	8%	9%	8.3%	8.7%	9%
Foreign matter	1%	1.1%	0.9%	1.2%	1%
Crude fiber	28%	15%	21.5%	25%	23.5%

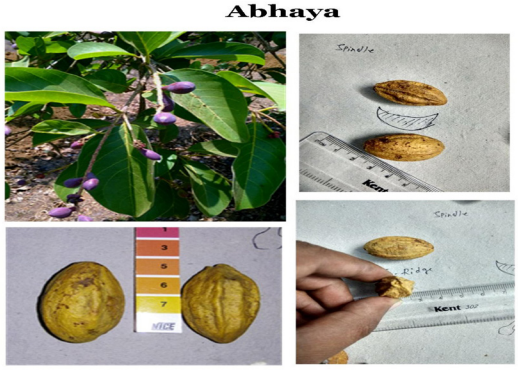

Figure 1: Abhaya variety of Myrobalan physical study.

water extract (2.09%) and *Vijaya* alcoholic (3.07%) than *Abhaya* Alcoholic (2.2%) and Gallic acid was more in *Rohini* water extract (3.12%) than *Pootani* water (1.12%) it was least in alcoholic extract as presented in Figure 8-9.

DISCUSSION

The current study is first of its kind in identification and possible co-relation of available sources of TC thus it as identified only 5-varieties as the study was restricted in north-western ghats of north Karnataka more-

Table 5: Fluorescence and behavior of powdered fruits under UV light and white light on treatment with chemical reagents

Reagent	Vijaya		Rohini		Pootana		Amirtha		Abhaya	
	WL #	F#	WL	F	WL	F	WL	F	WL	F
Plane powder	Light yellow	+	Light yellow	+	Yellow	+	Brownish	+	Light brown	+
Water	Yellowish	-	Light brown	-	light yellow	-	Deep brown	-	Brown	-
Aq Iodine	Light brown	-	Dark	-	Deep brown	-	Brown	-	Light dark	-
Nitric acid	Orange	+	Orange	+	Orange	+	Orange	+	light orange	+
Picric acid	Dark yellow	+	Yellow	+	Light yellow	+	Yellow	+	Light yellow	+
20% NaOH	Dark Brown	-	Dark Brown	-	Dark Brown	-	Dark Brown	-	Light red	-

WL: White light and F: Fluorescence

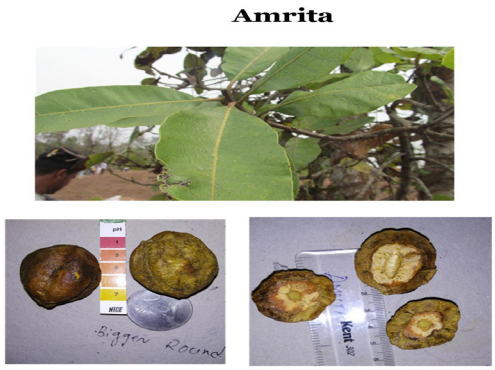

Figure 2: Amrita variety of Myrobalan physical study.

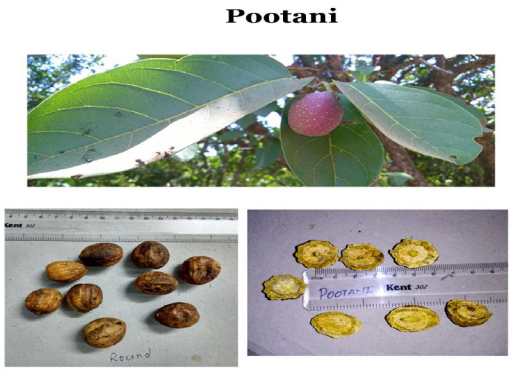

Figure 3: Pootani variety of Myrobalan physical study.

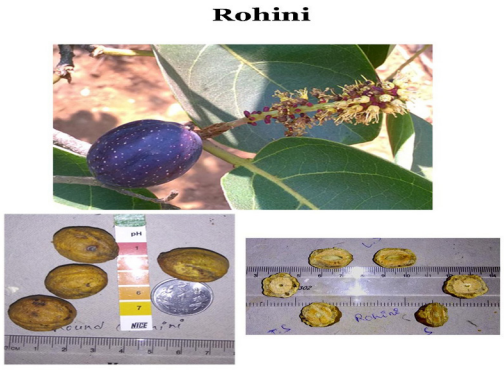

Figure 4: Rohini variety of Myrobalan physical study.

Figure 5: Vijaya variety of Myrobalan physical study.

over, Ayurvedic literature suggested that few varieties of TC are known to available only in sub Himalayan region.[2] Distribution of TC plants in different altitude depicts that *Amrita* variety with 2716foot alt has less % of phytochemicals compare to *Rohini* with 2656 foot, it potentiated the similar study conducted in different altitude of same plant with variability in phytochemicals suggested the higher altitude plants are rich source of phytochemicals than in lower altitude.[20] This could be the rationality of selecting higher altitude plants for clinical purpose in Ayurveda.

HPTLC study showed the presence of Chebulinic acid and Gallic acid and absence in quercetine and rutin as these chemicals are more soluble in Methanol than in other solvent.[21] The percentage of phytochemicals were more in water soluble extract compare to alcoholic extract, this could be the reason that TC formulations are more of water based.

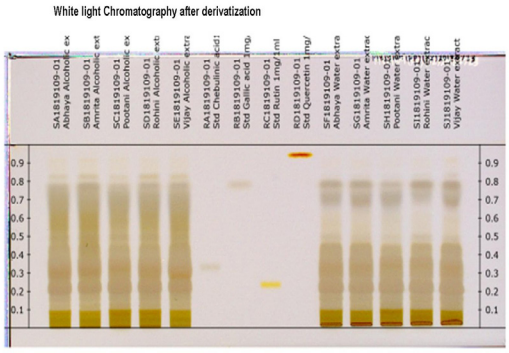

Figure 6: HPTLC Chromatography white light after derivatization.

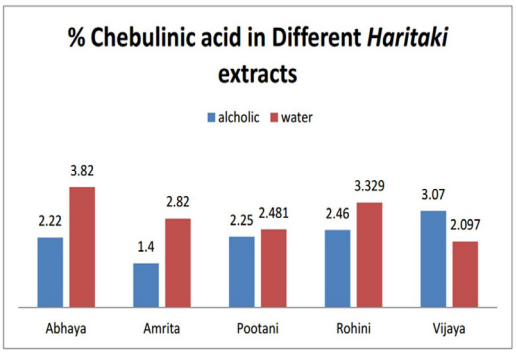

Figure 8: % of Chebulinic acid in different Myrobalan.

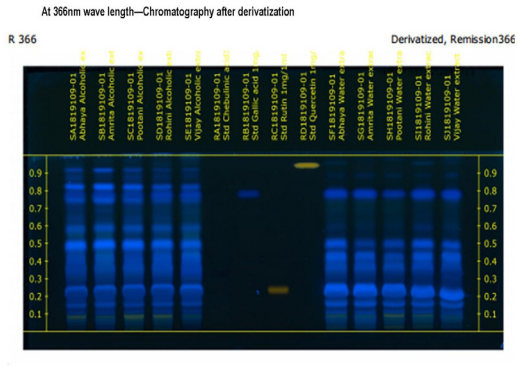

Figure 7: HPTLC Chromatography at 366nm wave length.

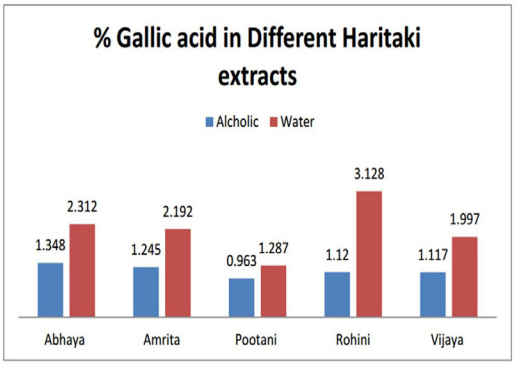

Figure 9: % of Gallic acid in different Myrobalan.

Table 6: Preliminary phytochemical analysis.

Test	Alcohol/Water Extract Samples				
	Vijaya	Rohini	Pootana	Amirtha	Abhaya
Carbohydrates	+/+	+/+	+/+	+/+	+/+
Pentose Sugars	+/+	+/+	+/+	+/+	+/+
Starch	+/+	+/+	+/+	+/+	+/+
Proteins	+/+	+/+	+/+	+/+	+/+
Alkaloid	+/+	+/+	+/+	+/+	+/+
Steroids	-/-	-/-	-/-	-/-	-/-
Saponins: Foam test	-/ Slightly present	-/ Slightly present	-/ Slightly present	-/ Slightly present	-/ Slightly present
Anthraquinon glycoside	+/+	+/+	+/+	+/+	+/+
Tannins and Phenolic compounds	+/+	+/+	+/+	+/+	+/+
Iron	+	+	+	+	+
Calcium	+	+	+	+	+
Magnesium	+	+	+	+	+
Sodium	+	+	+	+	+
Potassium	-	-	-	-	-
Sulphate	-	-	-	-	-
Phosphate	+	+	+	+	+
Chloride	+	+	+	+	+
Carbonate	+	+	+	+	+

Vijaya variety of TC has contained more percentage of Chebulinc acid and it is known for its potential action on GI tract as anti-tumour[21] anti-angiogenic,[22] anti-inflammatory[23] and anti-hypertensive[24] effects thus Ayurveda suggested to use these for curative purpose.[2]*Rohini* and *Abhaya* variety of TC are with maximum percentage of Gallic acid (Hydrolisable poly-phenol), this gallic acid is active ingredient known for its activities on free radical-scavenging, elastase inhibition, expression of matrix metalloproteinase-1 (MMP-1) and type I collagen synthesis in normal human fibroblast cells.[25-26] Thus, these actions may be useful in the management of *Vrina* (ulcer), geriatric population and GI disorder suggested by Ayurveda.[22]

Study Limitations and Scope

The current study merely provided the existence of difference varieties of TC and these varieties have shown actual variations in there phyto-chemicals. This variation could be because of distribution of plants, age of plant, genetical and time of collection etc. thus, actual gene variations and molecular identification of these plants can be assessed by RAPD (Random Amplified Polymorphic DNA) study. Thus, confirmed varieties can further verified on its clinical efficacy. This study has made initial efforts on identifying source plants for types of Haritaki, Further studies collecting samples from all over India might be helpful in better understanding.

CONCLUSION

The study potentially demonstrated the availability of varieties of Myrobalan explained according to Ayurveda. Among the 7 varieties, 5-different varieties are identified in North-western Ghats of north karnataka as *Vijaya*, *Rohini*, *Pootana*, *Amirtha* and *Abhaya* these can be correlated to *Termenalia chebula* Ver. 2 (typica/citrina), TC Ver. 3, TC Ver. *Tomentella,* TC Ver. Gangitica and TC Ver. *Parviflora,* Thewaites Enum respectively. There was gross phyto-chemical variation existed among these and this would certainly open the new research question on its genetical identity and efficacy.

ACKNOWLEDGEMENT

Authors acknowledge to Rajiv Gandhi University of Health sciences Bangalore for financial support in conduction of this study and VGST Govt. Karnataka for upgrading research lab and smooth conduction of this research at Rajiv Gandhi Education Society's Ayurvedic Medical College Hospital and PG Research Centre Ron, Gadag. Karnataka.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

TC: Termenalia chebula; **L:** Length; **B:** Breadth; **WL:** White light; **F:** Fluorescence; **+:** Present and **-:** Absent.

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Article History: Submission Date : 13-11-2018; Revised Date : 05-01-2019; Acceptance Date : 29-03-2019.
Cite this article: Manjunath A, Kottarshetty IB, Vinod U. Identification and Validation of Different Types of Fruit of Haritaki (Terminalia chebula Retz.) in North-Western Ghats of North Karnataka with Special Reference to HPTLC. J Young Pharm. 2019;11(3):254-60.